Polymer functionalization by luminescent supramolecular gel

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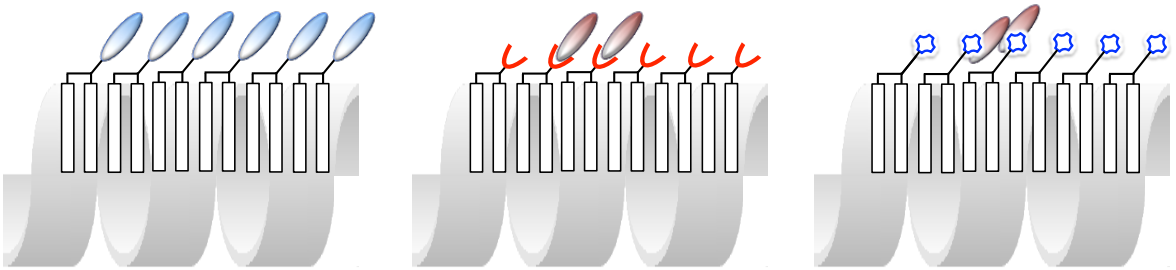
In this paper, we introduce chiroptically active, luminescent polymer films functionalized with chiral glutamide-based luminescent dyes. Glutamide is a generic term to indicate glutamic acid derivatives, which are characterized by a functional head group and double alkyl chains that combine to form glutamic acid through amide bonds. The dispersion properties of glutamides in both aqueous and non-aqueous systems are quite different from those of the corresponding ester-bonded derivatives. For example, when glutamide has a luminescent head group such as pyrene [1] or anthracene [2], it exhibits excimer emission with a large Stokes shift in dilute solution, whereas monomeric emission is observed for ester-bonded and non-glutamide derivatives. This difference is because glutamides form highly ordered aggregates through effective intermolecular hydrogen bonding interactions while the ester derivatives do not. The molecular ordering of glutamide also results in other interesting behaviors. In the case of L-enantiomeric glutamides in solution, extremely strong exciton coupling and circularly polarized luminescence are often observed. These supramolecular functionalities can also be found in mixed systems with polymers. For example, when a pyrene-immobilized L-glutamide was dissolved with suitable polymers such as polystyrene and poly(methyl methacrylate) in solution and then cast on a glass plate to form a thin solid film, the resulting polymer composites contained nanofibrillar aggregates and exhibited large Stokes shifts because of excimer emission and strong exciton coupling.

The advantage of a glutamide system is that non-luminescent glutamide can provide the above-mentioned chiroptical functionality when it is mixed with dyes, as shown in Figure 1b and c. This is caused by the formation of chiral stacking structures containing dye molecules. Such a system allows further expansion of chiroptical functionality [3].

In this paper, we demonstrate some applications of a luminescent glutamide-blended polymer system in light management technology. For example, when a transparent polymer functionalized with a pyrene-immobilized L-glutamide was coated on a copper indium gallium selenide solar cell, the power conversion efficiency was increased to 15.8%, compared with 15.0% for an uncoated cell. This increase in efficiency is caused by wavelength conversion upon absorption of UV-A light and the resulting visible excimer emission.



(a) (b) (c)

Fig. 1 Chiroptical, luminescent systems based on dye–supramolecular gel complexes that exhibit large Stokes shifts and circularly polarized luminescence.

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3. Y. Okazaki, T. Goto, Y. Kuwahara, M. Takafuji, R. Oda and H. Ihara, *Chem. Lett.*, in prints (2016).